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ABSTRACT

This paper demonstrates that the phonetic vowel sequences of Konni can be analyzed as a dipthongization of long mid vowels. Evidence from phonetics, phonological rules, and tone is cited to support this conclusion. The vowel harmony system of Konni is reviewed and underspecification of features is seen to play a crucial role in explaining vowel harmony. Vowel harmony and underspecification are combined with the coindexing concept of Bruce Hayes to account for dipthongization in Konni. (Author/MDM)

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DIPHTHONGIZATION AND UNDERSPECIFICATION IN KɔNNI[1]

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In this paper, I demonstrate that the phonetic vowel sequences of Kɔnni can be analyzed as a diphthongization of long mid vowels. Evidence from phonetics, phonological rules, and tone is cited to support this conclusion. The vowel harmony system of Kɔnni is reviewed and underspecification of features is seen to play a crucial role in explaining vowel harmony, (in particular, that /a/ is unspecified for [low]). Vowel harmony and underspecification are combined with the coindexing concept of Hayes (1990) to account for diphthongization in Kɔnni.

1. Introduction to the Kɔnni vowels

The problems of analyzing vowels of Gur languages are well-known to those who work among them. The bulk of the difficulty in Kɔnni comes in the analysis of the mid vowels, which manifest themselves in diverse and initially confusing ways.

The nine vowel phonemes[2] of Kɔnni divide into two harmony sets based on the Advanced Tongue Root feature:

(1)

+ATR		-ATR	
i	u	ɪ	ʊ
e	o	ɛ	ɔ
		a	

With very few exceptions, all vowels in a simple (i.e. non-compound) word come from only one of the two sets[3]:

(2)

+ATR words		-ATR words	
súúlì	'be full'	júúlɪ̀	'climb'
bítíéŋ	'beard'	tɔ́bɪ̀	'pierce'
tókórósí	'windows'	kúrúbā	'cooking pot'

The vowel harmony extends to all affixes of a word, for example:

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(3) Nouns: articles and plural markers

+ATR		-ATR	
tígí-rí	'the house'	kʊ̀ʊ̀-rɪ́	'the hoe'
sìè-kú	'the path'	nɪ̀ɪ̀-kú	'the rain'
dʊ̀ʊ̀m-bú	'the horse	nyáá-bú	'the water'
dʊ̀n-é-hé	'the knees'	dà-rá-há	'the days'
tókóró-sí-sí	'the windows'	nánjú-sɪ́-sɪ́	'the flies'
kʊ̀n-tí-tí	'the funerals'	sún-tɪ́-tɪ́	'the brooms'

(4) Verbs: aspect markers

+ATR		-ATR	
kʊ̀rì-yé	'has pounded'	pàsɪ̀-yá	'has peeled'
chìì-mé	'carry!'	dʊ̀-má	'bite!'
sʊ̀gʊ̀r-é	'is washing'	pɔ̀gɪ̀l-á	'is holding'
tʊ̀-ó	'is digging'	kʊ̀-á	'is killing'
dígí-wó	'cooked'	gá-!wá	'went'

Note that instead of the expected e/ɛ and o/ɔ variations, there are several cases of e/a and o/a alternations. This point will be returned to below.

2. A problem of interpretation

Though the short vowels present challenges of their own, this paper will focus on the problem presented by long vowels and phonetic vowel sequences.

Long vowels which are low ([aa]) and high ([ii], [ɪɪ], [uu], [ʊʊ]) are unambiguously attested:

(5)

dàáŋ	"wood"	wɪ́ɪ́ŋ	"problem"	dúúŋ	"horse"
háá'gɪ́ŋ	"bush"	kpɪ̀lɪ́ŋ	"ancestor"	bʊ̀ntʊ̀ʊ́ŋ	"toad"

Long mid vowels are rare, with *gbèéŋ* "a pot" being one of the few clear examples.

More frequent than long mid vowels are various vowel combinations:

(6)

bítíéŋ	"beard"	fɪ́ɛ́lɪ̀	"be cool"
jʊ̀ǫ́ŋ	"room"	kʊ̀ɔ́-kú	"the farm"
lí'áŋ	"ax"	dʊ̀áŋ	"bush-pig"
chɛ́àŋ	"waist"		

The question is, how are these phonetic vowel sequences to be interpreted phonologically? There are three possibilities: as phonemic vowel sequences, as vowel-glide-vowel sequences, and as diphthongs.

The distribution of the vowels within the "sequence" argues against phonemic vowel sequences. There is only a fraction of the possible vowel sequences represented; only 7 out of 32 possibilities for heterogeneous vowel sequences, taking ATR harmony into account, are attested. Furthermore, V2 is never a high vowel, whereas V1 is almost always so.

Interpretation as a glide sequence or diphthong seems more promising, and we turn now to those possibilities.

3. A glide sequence or not?

3.1 Arguments favoring glide presence

Arguments in favor of the presence of a glide center around two factors: the suspect nature of the sequences, and CV patterns of related languages.

First, a pattern that forces us to consider the possibility of a glide between the two vowels is that V1 of the apparent sequence is almost invariably high. As a general principle, it is difficult to hear the difference between [ɪa] and [ɪya], between [ʊa] and [ʊwa]. If in fact a glide were present, that would mean what I have cited as [lí'áŋ] should rather be [lí'yáŋ], and [dʊ̀áŋ] would be [dʊ̀wáŋ].

Second, related languages where adequate analysis is available indicate that the most common syllable patterns for Gur are CV and CVV, VV indicating a long homogeneous vowel. These are also unambiguous syllable patterns in Kɔnni . Interpreting the "sequences" as disyllabic, with the glide as the consonant of the second syllable, would fit nicely into this pattern.

The above considerations are not language-specific evidence, but comprise fairly strong pressure from phonetic universals and areal features. In the absence of more specific evidence, these would tip the scales toward the glide interpretation. However, there are several pieces of evidence within Kɔnni which oppose the glide theory.

3.2 Arguments against glide sequence

3.2.1 Evidence from phonetics

There are definitely [ɪya] sequences in Kɔnni. /ya/ is the perfective suffix on verbs, as in [gà-yá] 'has gone,' [kpàtɪ̀-yá] 'has finished.' There is in fact a slight phonetic difference between this [ɪya] and the sequences under consideration, many of which are monomorphemic. [ɪa] has more of a unitary nature; the [ɪ] is more transitory, being almost an on-glide.

The difference between [ɪa] and [ɪya] is also supported by instrumental timings[4], in which eight samples of /ɪya/ had an average duration of 0.30 seconds, while six samples of /ɪa/ had an average duration of 0.24 seconds. For [+ATR] forms, for which [e] is the counterpart of [a], the average times were 0.33 seconds for five samples of /iye/ and 0.24 seconds for eight samples of /ie/. All test cases involved morpheme boundaries at the end of words, e.g. [kpàsɪ̀-yá] 'have nailed,' [sɪ̀tɪ̀-yé] 'have poured,' [sɪ́-à] 'type of fish (pl.),' [bɪ́-è] 'goats'.

Additional measurements in nouns show that both homogeneous long vowels (aa, ii, ɪɪ, ʊʊ, uu) and putative

vowel sequences (ɪa, ie, ʊa, uo) had the same average duration of 0.19 seconds. These were all in the first syllable of disyllabic words, between stops.

3.2.2 Evidence from variability

Pronunciation of the [ɪya] sequences is constant, but I have heard quite a lot of variation in the [ɪa]/[ie] sequences, for example:

(7)

[kpɪáŋ] ~ [kpɛ́ɛ́ŋ] ~ [kpɛ́áŋ]	"chicken" (pl. [kpɪɛsɪ])
[gbìɛ́ŋ] ~ [gbɛ̀ɛ́ŋ]	"pot"

These variations can be explained in terms of well-motivated rules, as discussed below.

3.2.3 Evidence from tone

Tonal evidence also precludes the possibility of the glide solution. Kɔnni allows rising and falling tones only on the last syllable of a word. I assume these glides comprise a tone sequence:

(8)

L H	H H H L	H L	Note these are short vowels, and bear a maximum of 2 tones.
|/	| | |/	|/	
taŋ	kʊrʊba	kpi	
[tǎŋ]	[kúrúbâ]	[kpî]	
'stone'	'pot'	'die'	

Long vowels also bear a maximum of 2 tones:

(9)

[dàáŋ] 'wood' [yɪ́!ɪŋ] 'arrow' [bùntʊ̀úŋ] 'toad'

When the definite article is added to a word like those above, the long vowel no longer has two tones:

(10)

a.	[dàáŋ]	"wood"	[dàà-kú]	"the wood"
	L H		L H	
	|/		| |	
	daaŋ		daakʊ	
b.	[yɪ́!ɪŋ]	"arrow"	[yɪɪ-!rɪ]	"the arrow"
	H LH		H LH	
	| /		| |	
	yɪɪŋ		yɪɪrɪ	

I interpret this as the tones re-associating to maintain the Kɔnni prohibition against contour tones on non-word-final TBU's.

Therefore the unit that bears tone in Kɔnni is the syllable, not just the vowel or mora. A syllable can bear one or at most two tones. Syllables can have either short or long vowels, with or without a nasal coda, but the same restriction holds on all types of syllables.

So the question: do words like [lí!áŋ] 'ax' act tonally like they have two syllables, which means a /y/ could be present, or do they act like one syllable?

Tonally, they behave exactly like the unambiguous long vowels:

1) The "second vowel" never has a rising or falling tone, such as *[bīāŋ].
2) When the definite article is added to a monoysyllabic noun, the second tone associates with the article rather than the root:

(11)

a. chɪ̀áŋ "waist" chɪ̀à-ká "the waist"

```
  L H              L  H
  |/               |  |
chɪaŋ            chɪaka
```

b. lí!áŋ "ax" líá-!ká "the ax"

```
 H LH             H LH
 | /              |  |
lɪaŋ             lɪaka
```

This tonal data shows that phonetic vowel sequences act like single syllables. If so, then a glide /y,w/ cannot be present, since that would make such a sequence two syllables.

4. A solution - all sequences from long mid vowels

The above has established that both long vowels and phonetic vowel sequences are single syllables and so the phonetic vowel sequences do not contain a glide. I want to go a step further and claim all phonetic vowel sequences come from underlying long mid vowels, that is:

(12)

/ee/ --> [ie]
/ɛɛ/ --> [ɪa, ɛa, ɪɛ]
/oo/ --> [uo]
/ɔɔ/ --> [ʊa, ʊɔ]

One of the reasons is, of course, that the variations cited in (7) include long mid vowels. There is no reason to posit an abstract solution in this case. One of the cited forms can be taken as basic and the others derived from it.

Another reason for taking the long mid vowels to be basic rather than the vowel sequences is the comparative evidence from related languages (e.g. Mampruli). In several of these, Naden cites /ɛ,ɔ/ becoming [ya,wa], very close to what I am positing here (Naden 1988:22, 1989:154).

Finally, as noted before, there is a marked scarcity of phonetic long mid vowels, but plenty of the "vowel sequences" in question. The process above (12) explains this distributional gap, showing that long mid vowels generally manifest themselves as diphthongs.

The alternations in the above data can be accounted for by three optional rules. The first two are specific to the long vowels under discussion, while the third is needed independently to account for variation in short vowels. For convenience, I will formulate these in linear terms at this point.

The first rule, Kɔnni diphthongization, may be written informally as:

(13) Diphthongization (informal):

ee --> ie	Note: all vowel sequences are
ɛɛ --> ɪa	in same ATR harmony set.
oo --> uo	
ɔɔ --> ʊa	

It may seem unusual that /ɛɛ,ɔɔ/ would diphthongize to [ɪa,ʊa] rather than [ɪɛ,ʊɔ]. However, as noted in Section 1, the ATR pairs a/e and a/o are well-attested in several suffixes, e.g.:

(14)	-ATR		+ATR	
jɪbɪ-ká	'the knife'		dèmbì-ké	'the man'
dàrá-há	'the days'		dùné-hé	'the knees'
ʊ̀ sɪ-yá	'he has bathed'		ù sì-yé	'he has danced'
yɪ-wá	'give him'		yígí-wó	'catch him'
yá-wá	'have-EMPH'		kéŋ-wó	'come-EMPH'
kʊ̀-á	'is killing'		tù-ó	'is digging'

A more formal account and explanation of the ATR variation and diphthongization rule will be given in Sections 5 and 6, respectively.

The next rule is needed to account for variations such as [kpɪáŋ] ~ [kpɛáŋ] "chicken," where the first vowel lowers:

(15) Lowering: (optional)

$$V \rightarrow [-high] \; / __ \; \begin{matrix} V \\ [+low] \end{matrix}$$

As far as I know, this process occurs only when vowels are adjacent. The rule as written would give ɪa --> ɛa as

above, and also ʊa --> ɔa, though I have no clear cases of the latter yet.

The third rule involves a fronting of /a/ when followed by /ɪ/ in the next syllable:

(16) Fronting of a (optional)

$$V \;\; [+low] \;\; \rightarrow \;\; [-back] \;\; / __ \;\; C \;\; V[-back]$$

That is, /a/ --> [ɛ] before /ɪ/, and presumably /ɛ/, though I have no cases of the latter. (The vowel I have transcribed as [ɛ] here can sometimes be phonetically lower as well, thus the rule refers to [back] as the changed feature and not necessarily to height.) This rule is needed independently in the case of short vowels in separate syllables:

(17) yásɪ ~ yésɪ 'salt'
bálɪ́ká ~ bélɪ́ká 'language'

It also explains the variations in the vowels under consideration here:

(18) pɪasɪ ~ pɪɛsɪ 'ask'

Here are derivations of the several attested forms of /kpɛ́ɛ́ŋ/ 'chicken' and /kpɛ́ɛ́sɪ́/ 'chickens':

(19)

Underlying:	/kpɛɛŋ/	/kpɛɛŋ/	/kpɛɛŋ/	/kpɛɛsɪ/
Diphthong.	-	kpɪaŋ	kpɪaŋ	kpɪasɪ
Lowering	-	-	kpɛaŋ	-
Fronting	-	-	-	kpɪɛsɪ
Surface	[kpɛɛŋ]	[kpɪaŋ]	[kpɛaŋ]	[kpɪɛsɪ]

5. Underspecification and Vowel Harmony in Kɔnni

To explain the workings of diphthongization in Kɔnni, it is first necessary to review the workings of vowel harmony and the role underspecification plays in it.

Recall that affixes of verbs and nouns harmonize with the root. Besides the usual alternations involving only the [ATR] feature, suffixes with /a/ alternate with /e/ and /o/:

(20) (reproduced from (4))

chɪ̀ɪ̀-mé	'carry!'	dʊ̀-má	'bite!'
sùgùr-é	'is washing'	pɔ̀gɪ̀l-á	'is holding'
tʊ̀-ó	'is digging'	kʊ̀-á	'is killing'
dígí-wó	'cooked'	gá-!wá	'went'

These data are analyzed in Cahill (in preparation), which I summarize here. To explain the alternations present, I invoke the concept of Radical Underspecification, as expounded in Archangeli (1988) and applied in Pulleyblank (1986). The latter's analysis of ɔkpɛ is very similar to what is proposed for Kɔnni, and my analysis is indebted to his in large measure.[5]

In Radical Underspecification, all values of features which are predictable are deemed unnecessary in underlying representation. Only one value of any particular feature is allowed to be present underlyingly; the other value is inserted by a redundancy rule. In Kɔnni, the full inventory of features for vowels is:

(21) FEATURE SPECIFICATIONS FOR KƆNNI VOWELS:

	i	ɪ	e	ɛ	a	ɔ	o	ʊ	u
BACK	-	-	-	-	+	+	+	+	+
ROUND	-	-	-	-	-	+	+	+	+
HIGH	+	+	-	-	-	-	-	+	+
LOW	-	-	-	-	+	-	-	-	-
ATR	+	-	+	-	-	-	+	-	+

The values of [back] are derivable from [round] and [low]. They have been omitted below for clarity of presentation. The following redundancy rules are applied (for a justification of these particular rules, see Cahill (in preparation)):

(22) Redundancy rules for Kɔnni vowels:

lexical: [+round] --> [-low]
[+ATR] --> [-low]

post-lexical: [ ] --> [+high]
[ ] --> [-ATR]
[ ] --> [-round]
[ ] --> [+low]

Once redundancy rules have begun to apply, they are assumed to apply throughout the course of a derivation, whenever they can. Taking these rules into account, the matrix in (21) is reduced to:

(23) UNDERLYING SPECIFICATIONS OF KƆNNI VOWELS:[6]

	i	ɪ	e	ɛ	a	ɔ	o	ʊ	u
ROUND						+	+	+	+
HIGH			-	-	-	-	-		
LOW		-		-					
ATR	+		+				+		+

As will be seen, the crucial aspect of the above for vowel harmony is that /a/ is unspecified for [low]. I assume that /a/ is the underlying segment in such cases, and the

interaction of spreading and redundancy rules accounts for its alternation with /e/ and /o/.

To account for the a/o alternation in suffixes, we note that /o/ in such alternations occurs only directly after either a /u/ or /w/. Therefore a rule of Round Spread is also needed:

(24) Round Spread[7]

Note:
X may be either vowel or glide.

The derivation of [tùó] 'is digging' and [kùá] 'is killing' follows. The representations below are intended to be abbreviated forms of a full hierarchical feature tree (see (27)). Nothing crucial hinges on the hierarchy here, so the relevant nodes and also tone are omitted for conciseness and clarity.

(25) Derivation of [tùó] and [kùá]

a. Underlying forms, ATR association:

b. Imperfective /-A/ affixation, with ATR spread:

c. Lexical redundancy rules:

d. Round Spread:

e. Post-lexical redundancy rules:

6.Coindexing

Recall that diphthongization process in Kɔnni is:

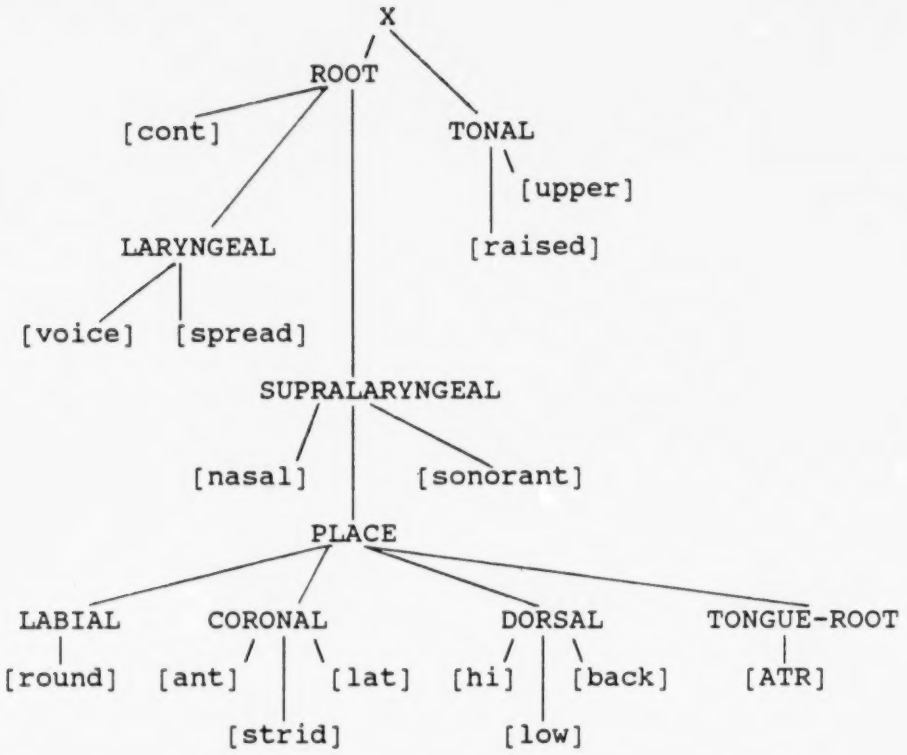
(26)

	[+ATR] set	[-ATR] set
front	ee --> ie	ɛɛ --> ɪa
back	oo --> uo	ɔɔ --> ʊa

The challenge is to represent these changes as a unitary process. The a/e and a/o alternations in vowel harmony above depended on having the vowel /a/ unspecified for most place features, particularly [low]. The dipthongization process likewise depends on removing most place feature specifications from the second V. In addition, diphthongization makes the first V [+high]. To specify this, I will use Hayes' format of coindexing.

A tree model of feature organization was proposed by Clements (1985), and modified by Sagey (1986) and others. The idea is to relate all features autosegmentally to a skeleton position (or CV position, depending on your theoretical preference), while at the same time incorporating the grouping of certain features together. Though the basic idea of grouping features in hierarchical trees is now widely accepted, the exact structure continues to be a matter for further research. One version of this tree, adapted and abbreviated from Archangeli & Pulleyblank (1989), is shown below. Capitals indicate nodes, and features are indicated by the usual brackets.[8]

(27)



Hayes (1990) has pointed out that this model (and by implication, its CV phonology predecessor) suffers from a serious defect in dealing with diphthongization processes. In the framework above, long vowels are conceived of as a feature matrix, or tree, linked to two V slots:

(28)

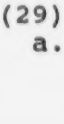
Most if not all diphthongization processes convert a long segment to a heterogeneous sequence, e.g. /ee/ --> [ei]. The difficulty arises because the data demands two different features on the the two V slots, e.g. [-high] on V_1 and [+high] on V_2, but the model above allows only one value of [high] which must be applied to both V slots. This is Hayes' "diphthongization paradox."

Hayes begins to resolve this paradox by noting that there is an ambiguity in what the lines in phonological representations indicate. Sometimes the lines indicate simultaneity, as in a High tone pronounced simultaneously with the vowel /a/ (below). Other times they indicate category membership, as in

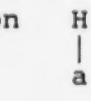
the example where [t a p] all belong to the same syllable (reproduced from Hayes 1990:40):

(29)

a. Association Lines



b. Category Membership Lines

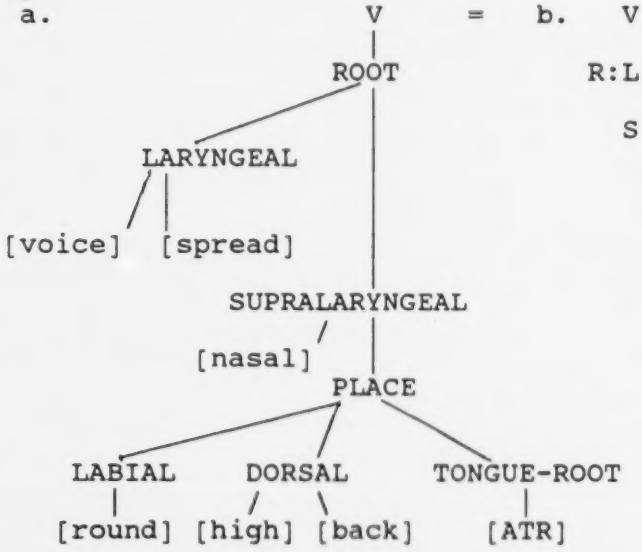


$= [tap]_s$

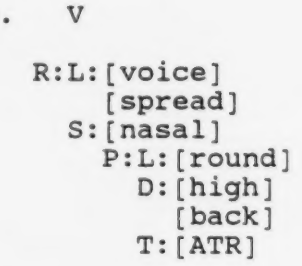
In the representation in (27), the lines serve both functions. On one hand, they indicate category membership in the feature hierarchy, and on the other, they link features to the CV tier to be simultaneously pronounced. Hayes proposes a way to separate the two functions. His formulation involves replacing the partial tree representation in (a) with an outline format as in (b) below:

(30)

a.



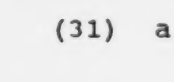
= b.



The indentations in the outline format indicate membership, just as lines do in the tree format. Thus the Root node **R** consists of the Laryngeal and Supralaryngeal nodes **L** and **S**, the Supralaryngeal node consists of [nasal] and the Place node **P**, and so on.

Simultaneity of pronunciation is provided by coindexation; the CV tier is labeled with indices and then the features are "coindexed" to them. For example, the word "secret" is shown below with both association lines and indices. (Here, feature trees are abbreviated by the appropriate phonetic symbols.)

(31) a.



b. $C_1\ V_2\ V_3\ C_4\ C_5\ V_6\ C_7$

$s_1\ i_{23}\ k_4\ r_5\ ə_6\ t_7$

The default case is that if a node is coindexed with a particular C or V, all nodes and features dominated by this node are also indexed to that same C or V. This is more formally stated as a Percolation Convention:

(32) Percolation Convention:
When indices are assigned to or removed from a node N, the assignments and deletions are automatically carried over to all nodes dominated by N. (Hayes 1990:44)

An example of how this works is illustrated below. In Kɔnni, the representation of long /u:/ involves two V positions associated with the features for /u/. The Percolation Convention assigns the indices for V_1 and V_2 to every node in the feature tree:

(33) V_1 V_2

R_{12}:L:[+voice]	-->	R_{12}:L_{12}:[+voice]$_{12}$
S:[-nasal]		S_{12}:[-nasal]$_{12}$
P:L:[+round]		P_{12}:L_{12}:[+round]$_{12}$
D:[+high]		D_{12}:[+high]$_{12}$
[-low]		[-low]$_{12}$
T:[+ATR]		T_{12}:[+ATR]$_{12}$

In formalizing rules using the coindexing notation, the structural description and change is given, including the relevant tiers. Hayes (1990:47) gives the following example of Old French diphthongization (/e: o:/ --> [ei ou]):

(34) Old French Diphthongization:

V_iV_j	CV tier
[-low]$_{ij}$	[low] tier
Delete j: [-high]$_{ij}$	[high] tier

The structural description is that [-low] and [-high] are linked to adjacent V positions, that is, we have a long mid vowel. The structural change is that the index j is deleted from the [high] tier, making the second V position unspecified for height[9] . Hayes then assumes a default rule assigning [+high] applies, raising the second V.

Note that the order in which the tiers are listed on the page is not significant. The CV tier could be listed second or third, for example, and it would still be the same rule.

7. Toward formalizing diphthongization

Now we are in a position to formulate the diphthongization rule for Kɔnni:

(35) Diphthongization:

	V_iV_j	CV tier
	$[-low]_{ij}$	[low] tier
delete $_i$, insert $[-high]_j$	$[-high]_{ij}$	[high] tier
delete $_j$	$PLACE_{ij}$	Place tier

In words, the structural description is that [-low] and [-high] are linked to adjacent V slots, that is, we have a long mid vowel. The structural change is two-fold. First, the **i** index is deleted from the [high] tier on the first V, and [-high] is inserted for the second V. (A [+high] value for V_i will later be inserted by redundancy rule.) Second, the **j** index is deleted on the PLACE node. The result is that all place features are deleted for the second V, except [-high]. Various spreading and default rules will fill in these features. The net effect of the diphthongization rule makes V_i a high vowel and gives V_j the underlying features of /a/.

For conciseness' sake, in the derivations below, only the place node and its daughters are shown after diphthongization has applied. The redundancy rules in (22) and the underlying specifications in (23) are assumed. Once redundancy rules have begun to apply, they are assumed to apply at all stages of a derivation, whenever they can (see Pulleyblank 1986). Below, when 0F is used (where F stands for any feature, as in 0Rd or 0Hi), that implies the absence of that feature and all supporting hierarchical structure. 0F is used here merely as a convenient bookkeeping device, with no theoretical claims made regarding it.

(36) <u>Derivation of [ie] and [ɪa] from /ee/ and /ɛɛ/:</u>

a. Underlying forms:

/ee/	/ɛɛ/
V_1V_2	V_1V_2
R_{12}:S:P:T:[+ATR]	R_{12}:S:P:T:[0ATR]
L:[0Rd]	L:[0Rd]
D:[-Hi]	D:[-Hi]
[0Lo]	[-Lo]

b. Percolation:

V_1V_2	V_1V_2
R_{12}:S_{12}:P_{12}:T_{12}:$[+ATR]_{12}$	R_{12}:S_{12}:P_{12}:T_{12}:$[0ATR]_{12}$
L_{12}:$[0Rd]_{12}$	L_{12}:$[0Rd]_{12}$
D_{12}:$[-Hi]_{12}$	D_{12}:$[-Hi]_{12}$
$[0Lo]_{12}$	$[-Lo]_{12}$

c. Lexical redundancy rules:

V_1V_2	V_1V_2
R_{12}:S_{12}:P_{12}:T_{12}:[+ATR]$_{12}$	R_{12}:S_{12}:P_{12}:T_{12}:[0ATR]$_{12}$
L_{12}:[0Rd]$_{12}$	L_{12}:[0Rd]$_{12}$
D_{12}:[-Hi]$_{12}$	D_{12}:[-Hi]$_{12}$
[-Lo]$_{12}$	[-Lo]$_{12}$

d. Diphthongization:

V_1V_2	V_1V_2
P_1:T_1:[+ATR]$_1$[0ATR]$_2$	P_1:T_1:[0ATR]$_{12}$
L_1:[0Rd]$_{12}$	L_1:[0Rd]$_{12}$
D_1:[+Hi]$_1$[-Hi]$_2$	D_1:[+Hi]$_1$[-Hi]$_2$
[-Lo]$_1$[0Lo]$_2$	[-Lo]$_1$[0Lo]$_2$

e. Reapplication of redundancy rules and ATR spread:

V_1V_2	V_1V_2
P_{12}:T_{12}:[+ATR]$_{12}$	P_{12}:T_{12}:[0ATR]$_{12}$
L_{12}:[0Rd]$_{12}$	L_{12}:[0Rd]$_{12}$
D_{12}:[+Hi]$_1$[-Hi]$_2$	D_{12}:[+Hi]$_1$[-Hi]$_2$
[-Lo]$_{12}$	[-Lo]$_1$[0Lo]$_2$

f. Postlexical redundancy rules:

V_1V_2	V_1V_2
P_{12}:T_{12}:[+ATR]$_{12}$	P_{12}:T_{12}:[-ATR]$_{12}$
L_{12}:[-Rd]$_{12}$	L_{12}:[-Rd]$_{12}$
D_{12}:[+Hi]$_1$[-Hi]$_2$	D_{12}:[+Hi]$_1$[-Hi]$_2$
[-Lo]$_{12}$	[-Lo]$_1$[+Lo]$_2$
[ie]	[ɪa]

(37) Derivation of [uo] and [ʊa] from /oo/ and /ɔɔ/:

a. Underlying forms:

V_1V_2	V_1V_2
R_{12}:S:P:T:[+ATR]	R_{12}:S:P:T:[0ATR]
L:[+Rd]	L:[+Rd]
D:[-Hi]	D:[-Hi]
[0Lo]	[0Lo]

b. Percolation:

V_1V_2	V_1V_2
R_{12}:S_{12}:P_{12}:T_{12}:[+ATR]$_{12}$	R_{12}:S_{12}:P_{12}:T_{12}:[0ATR]$_{12}$
L_{12}:[+Rd]$_{12}$	L_{12}:[+Rd]$_{12}$
D_{12}:[-Hi]$_{12}$	D_{12}:[-Hi]$_{12}$
[0Lo]$_{12}$	[0Lo]$_{12}$

c. Lexical redundancy rules:

V_1V_2 → $R_{12}:S_{12}:P_{12}:T_{12}:[+ATR]_{12}$ $L_{12}:[+Rd]_{12}$ $D_{12}:[-Hi]_{12}$ $[-Lo]_{12}$

V_1V_2 → $R_{12}:S_{12}:P_{12}:T_{12}:[0ATR]_{12}$ $L_{12}:[+Rd]_{12}$ $D_{12}:[-Hi]_{12}$ $[-Lo]_{12}$

d. Diphthongization:

V_1V_2 → $P_1:T_1:[+ATR]_1[0ATR]_2$ $L_1:[+Rd]_1[0Rd]_2$ $D_1:[+Hi]_1[-Hi]_2$ $[-Lo]_1[0Lo]_2$

V_1V_2 → $P_1:T_1:[0ATR]_{12}$ $L_1:[+Rd]_1[0Rd]_2$ $D_1:[+Hi]_1[-Hi]_2$ $[-Lo]_1[0Lo]_2$

e. Reapplication of redundancy rules and ATR spread:

V_1V_2 → $P_{12}:T_{12}:[+ATR]_{12}$ $L_{12}:[+Rd]_1[0Rd]_2$ $D_{12}:[+Hi]_1[-Hi]_2$ $[-Lo]_{12}$

V_1V_2 → $P_{12}:T_{12}:[0ATR]_{12}$ $L_{12}:[+Rd]_1[0Rd]_2$ $D_{12}:[+Hi]_1[-Hi]_2$ $[-Lo]_1[0Lo]_2$

f. Round spreading:

V_1V_2 → $P_{12}:T_{12}:[+ATR]_{12}$ $L_{12}:[+Rd]_{12}$ $D_{12}:[+Hi]_1[-Hi]_2$ $[-Lo]_{12}$

V_1V_2 → $P_{12}:T_{12}:[0ATR]_{12}$ $L_{12}:[+Rd]_1[0Rd]_2$ $D_{12}:[+Hi]_1[-Hi]_2$ $[-Lo]_1[0Lo]_2$

g. Postlexical redundancy rules:

V_1V_2 → $P_{12}:T_{12}:[+ATR]_{12}$ $L_{12}:[+Rd]_{12}$ $D_{12}:[+Hi]_1[-Hi]_2$ $[-Lo]_{12}$

[uo]

V_1V_2 → $P_{12}:T_{12}:[-ATR]_{12}$ $L_{12}:[+Rd]_1[-Rd]_2$ $D_{12}:[+Hi]_1[-Hi]_2$ $[-Lo]_1[+Lo]_2$

[ʊa]

Not only must the rules generate the correct diphthongs, but also must not change the high and low long vowels. It can be readily determined that neither of these are affected by dipthongization.

7. A Psycholinguistic Observation

Of the four rules affecting vowels discussed here, two have been treated as lexical rules: Diphthongization (35) and Round Spread (24). This relates to an interesting

psycholinguistic factor - the spelling of mother-tongue Kɔnni speakers.

At present, there are only three adult literate Komas. These are agreed that the preferred spelling of words discussed above is with the letters {ia,ie,ua,uo}. These correspond, of course, to the sequences [ɪa,ie,ʊa,uo] (The symbols ɪ and ʊ were not part of their knowledge at the time.) For example, even with the extreme variations in phonetic realization of /ɛɛ/ (ɛɛ ~ ɪa ~ ɛa ~ ɪɛ - see (7)), Kɔnni speakers are adamant in writing it as {ia}.

These preferred spellings correspond to the output of the lexical component of the phonology. To the extent that the output of lexical rules corresponds roughly to the traditional phonemic level and that this level has psychological reality (Mohanan 1986, especially chapter 7), then this reaction of native speakers of Kɔnni supports the assertion that Diphthongization and Round Spread are lexical rules and the others are post-lexical.

9. Conclusion

Starting from the phonetic data, I have demonstrated that apparent vowel sequences in Kɔnni are diphthongs derived from long mid vowels. The critical aspect of the analysis is that /a/ is unspecified for [low] in underlying representation. This not only accounts for the alternation of /a/ with /e/ and /o/ in short vowels of suffixes, but also for the same variation in V_2 of the diphthongs: [ie] and [ɪa], [uo] and [ʊa]. To formalize a diphthongization rule, Hayes' coindexation scheme was utilized, thus making it possible to assign heterogeneous features to V_1 and V_2, an impossibility under the standard hierarchical tree representation of long vowels.

[1] Kɔnni is a Gur language (Western Oti-Volta branch) whose closest relative is Buli. The people are Koma, the language Kɔnni. The only published works dealing exclusively with the language are Naden (1987) and Cahill (1992a,b), though a few Kɔnni examples are cited in Naden (1988, 1989). The data in this paper was gathered over several periods since 1986, mostly in the village of Yikpabongo. I wish to extend my thanks to Mr. Abdulai Sikpaari and Mr. Ben Saibu for sharing their mother tongue with me, and Don Burquest and Rod Casali for their remarks on earlier versions of this paper. Any faults that remain are, unfortunately, my responsibility alone.

[2] Consonantal phonemes of K nni are (in orthographic symbols): b ch d f g gb h j k kp l m n ŋ ŋm ny p s t v w y z. For justification of these and vocalic phonemes, as well as a discussion of various rules that affect vowels, see Cahill (1992b).

[3] Unless otherwise noted, transcriptions are given in phonemic form. Though not in focus for most of the paper,

tone is included for completeness' sake. For nouns, tone is taken from the citation form; for finite verb forms, it is taken from the third person singular pronoun subject form.

[4] Instrumental analysis was done with SIL's CECIL hardware and software package. The tape recording on which the analysis was done was of one speaker during one session.

[5] Alternate positions on underspecification, such as Contrastive Underspecification, are not considered here. The arguments in Pulleyblank (1986) in favor of Radical Underspecification largely apply in the case of Kɔnni.

[6] Many analyses using Radical Underspecification posit one vowel as totally unspecified for place in underlying representation, but this is not strictly required by the theory. Unlike most languages where a Radical Underspecification analysis has been applied - Ɔkpɛ (Pulleyblank 1986), Gengbe (Abaglo & Archangeli 1989), and Yoruba (Pulleyblank 1988), for example - Kɔnni has no single vowel which exhibits a convergence of properties that would lead one to wholly underspecify it for place features. In this, it more closely resembles Kasem (Haas 1988) and Esimbi (Hyman 1988).

[7] The application of this rule is limited to suffixes, both verbal and nominal. Roots do exist which have /w/ followed by front vowels, e.g. /wɛ/ 'to break,' /wieli/ 'to sit by fire,' /wɪarɪ/ 'to remain,' /wíĺŋ/ 'problem.' These are not nearly as common as roots with /w/ followed by a back round vowel, but they do not seem to be exceptional forms. A precise delineation of the application of Round Spread will have to await a further investigation of the lexical strata of Kɔnni; for now, it suffices to say that it is a lexical rule applying to suffixes.

[8] Odden (1991) proposes a separate node for all vowel place features. While some version of his proposal is probably correct, as far as I can tell the precise hierarchical structure does not affect the issues presented here.

[9] Bird (1991) raises the issue of whether a node whose index has been deleted should be considered as floating or as having been deleted. My assumption, following Hayes' suggestion (cited in Bird 1991:140) is that the relevant node is deleted, then later regenerated as daughter features are assigned by spreading or redundancy rules. This seems to be more consistent with a scheme which generates nodal structure upon initial assignment of features (Archangeli & Pulleyblank 1989:196). However, nothing crucial in this analysis hinges on this issue.

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